2014 FAA Worldwide Airport Technology Transfer Conference

REHABILITATION OF WATER-DAMAGED RUNWAY COMPOSITE PAVEMENTS

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SCOPE

JAPAN

Introduction

- South end 750 m of Runway A of NRT
  - Required to fully use
- Endmost 150 m section
  - Required to be more durable
- Composite pavement
  - Asphalt mixture (AM) layers placed on continuously reinforced concrete (CRC) slabs
  - Constructed in 2011 autumn - 2012 spring
- Some signs of distress
  - Appeared several months after construction

NARITA AIRPORT

SCOPE

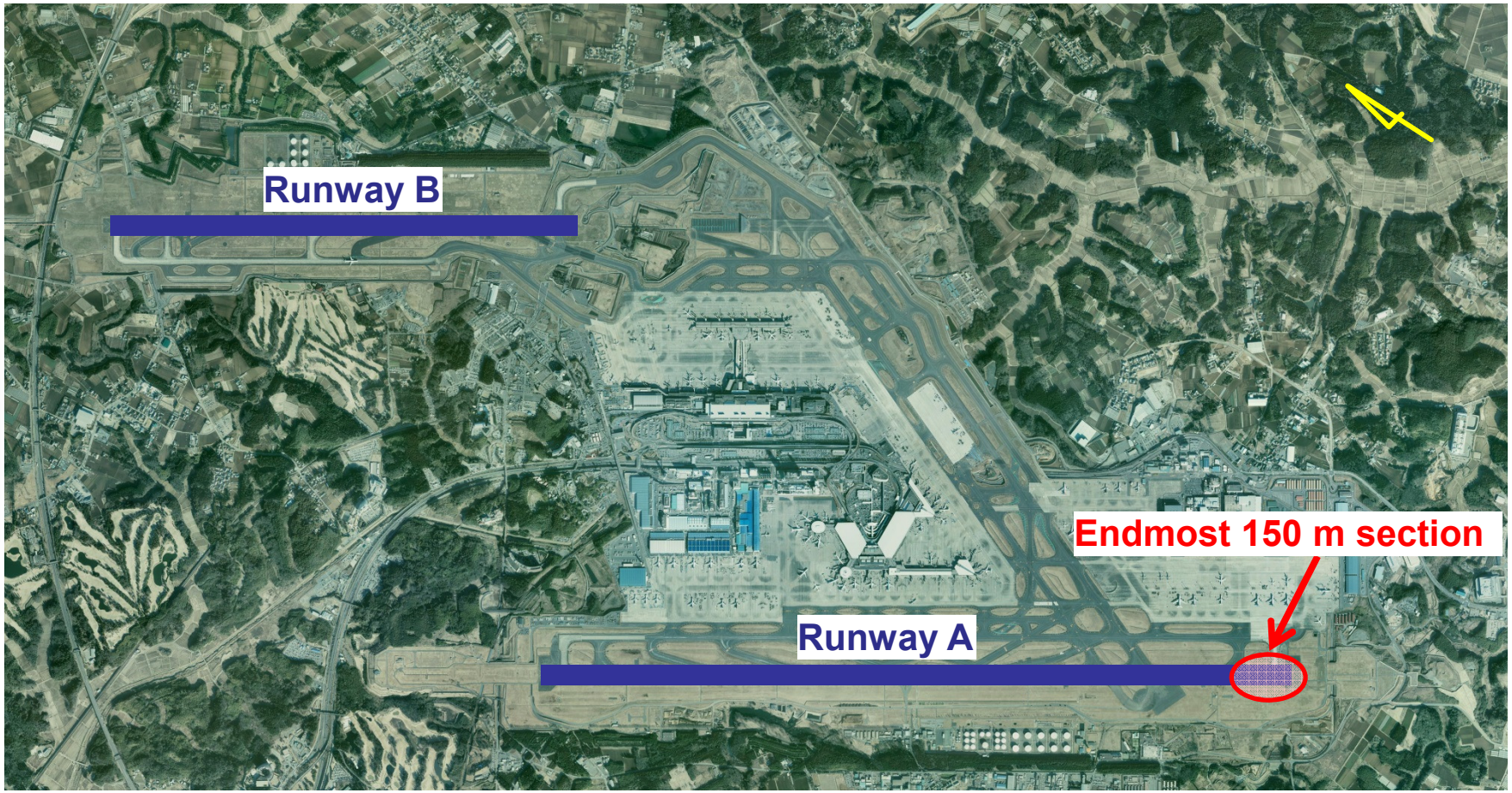
Introduction (Cont'd)

- Tentative repairs
  - Cut & overlay of AM in the same way
  - Some signs of distress were also appeared
- Causes of distress
  - Studied in several different ways
  - Classified into two kinds
    - Intrusion of water into AM
    - Low stability of AM
- Rehabilitation method
  - Cut & overlay of AM in the proposed way
  - Installation of water draining facilities

NARITA AIRPORT

SCOPE

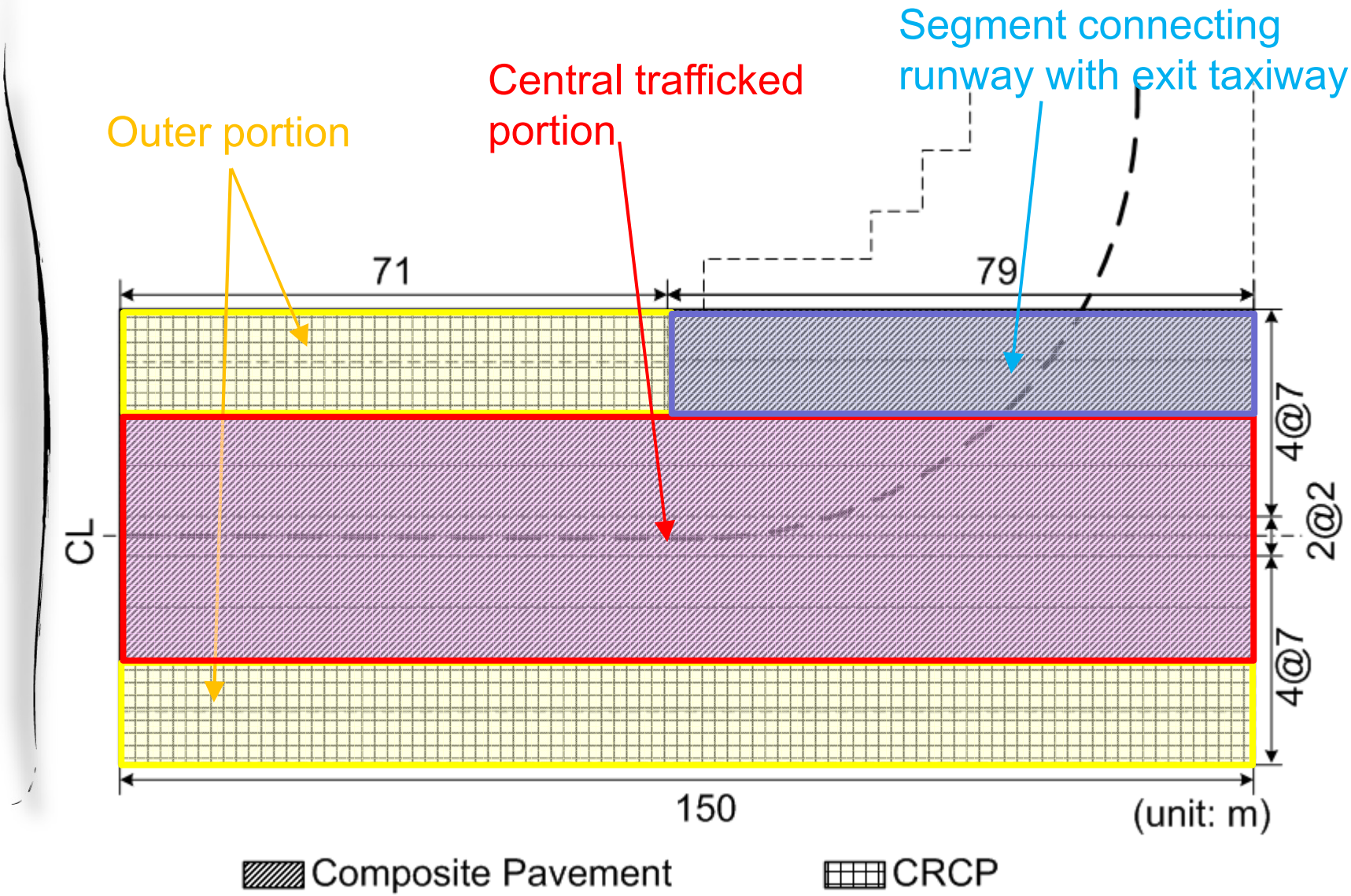
Narita International Airport



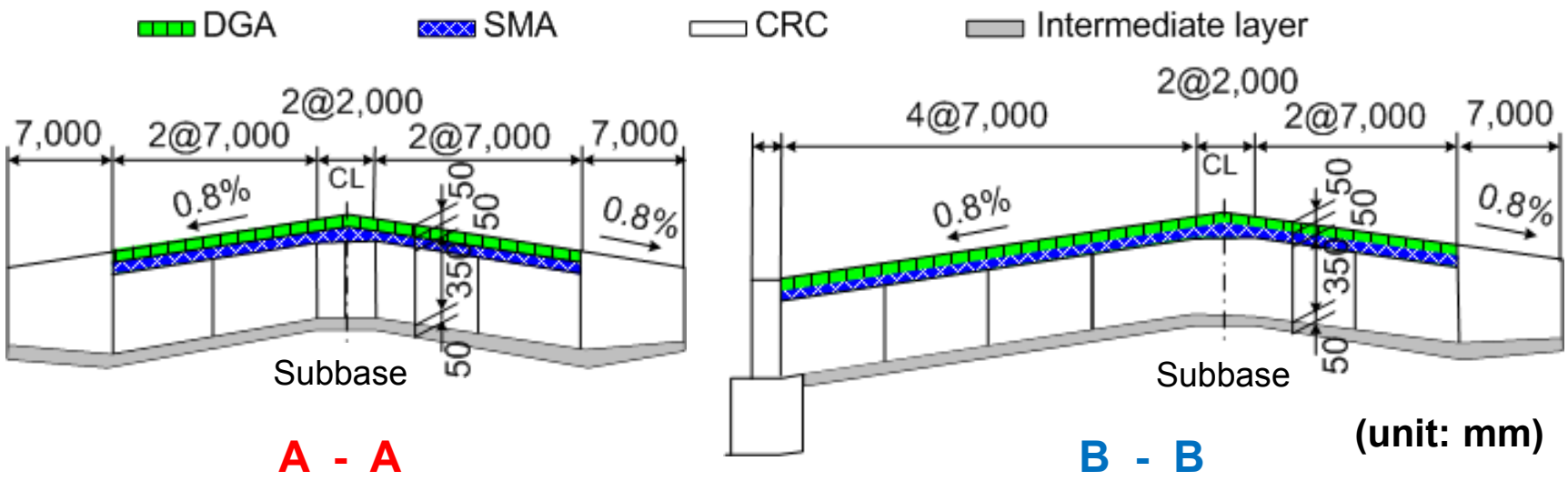
NARITA AIRPORT

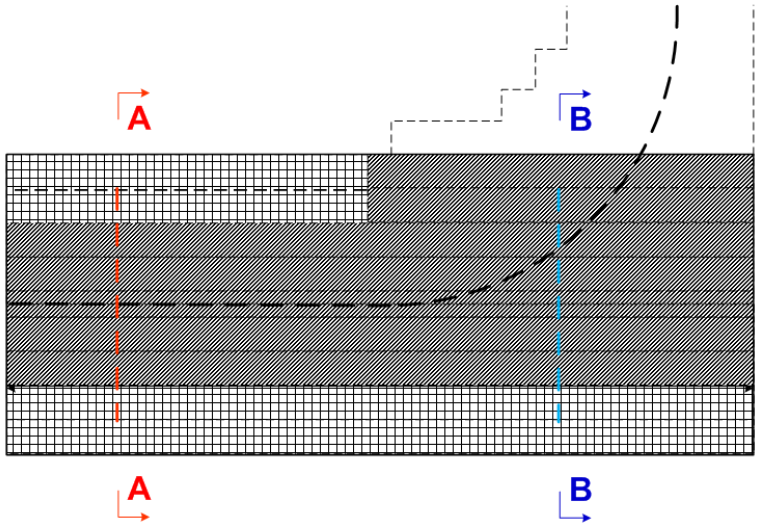
SCOPE

Composite Pavement: Plan



Composite Pavement: Section

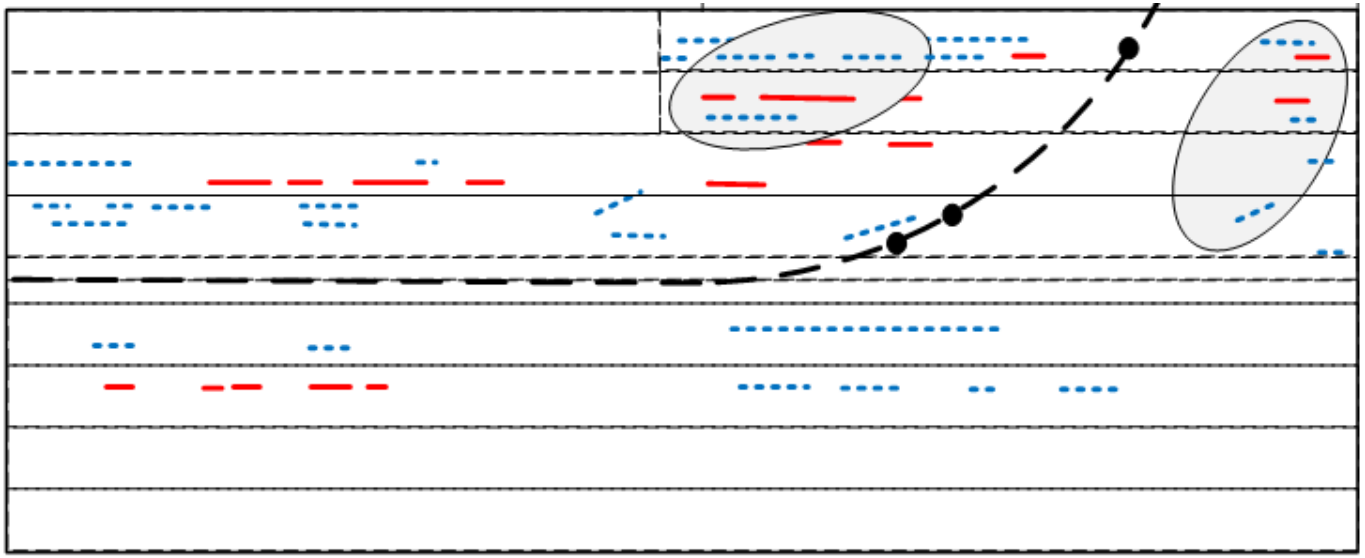




- Composite pavement
  - 100 mm thick AM
    - 50 mm thick DGA Surface
    - 50 mm thick SMA Binder
  - 350 mm thick CRC
- AM layers
  - Surrounded by concrete slabs

Signs of Distress on Surface

- Composite pavements
  - Open to aircraft operation in April 2012
- Some signs of distress
  - Appeared on surface a few months later



Signs of Distress (1)

- Dull sound at hammer tapping tests
- Flow of AM around airport lighting

Signs of Distress (2)

- Black spots

- White spots

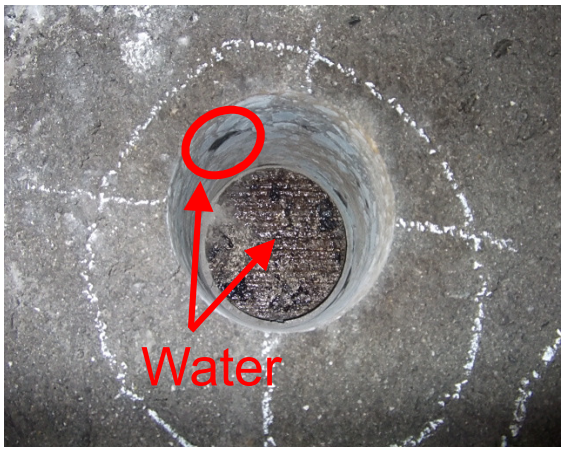
- Stains at construction joints

Study on Causes of Distress

- Properties of cored samples taken from AM
  - Conditions of cores were visually inspected.
  - Various properties were measured in the cores.
  - Chemical compositions of the spots and stains were identified.
- Structural conditions of pavements
  - The response of composite pavement to aircraft loads was analyzed by using 3D-FEM

Conditions and Properties (1)

- Fracture of AM
  - Marks of slippage between AM and CRC
  - Fractured planes in AM and at AM interface
- Water in AM
  - Found between AM and CRC, and in the fractured planes.



Water content of AM (unit: %)

Area	Surface	Binder
Dull sounding	0.43	0.81
Sound	0.16	0.26

Conditions and Properties (2)

- Thickness
  - Ave. AM thickness in concave areas is 33, 40 mm in surface, binder course, respectively
- Dynamic stability of surface course AM
  - Dynamic stability (DS) satisfied the specification of DS > 300 times/mm

Dynamic stability

Sound Area		Dull sounding area	
413	458	510	960

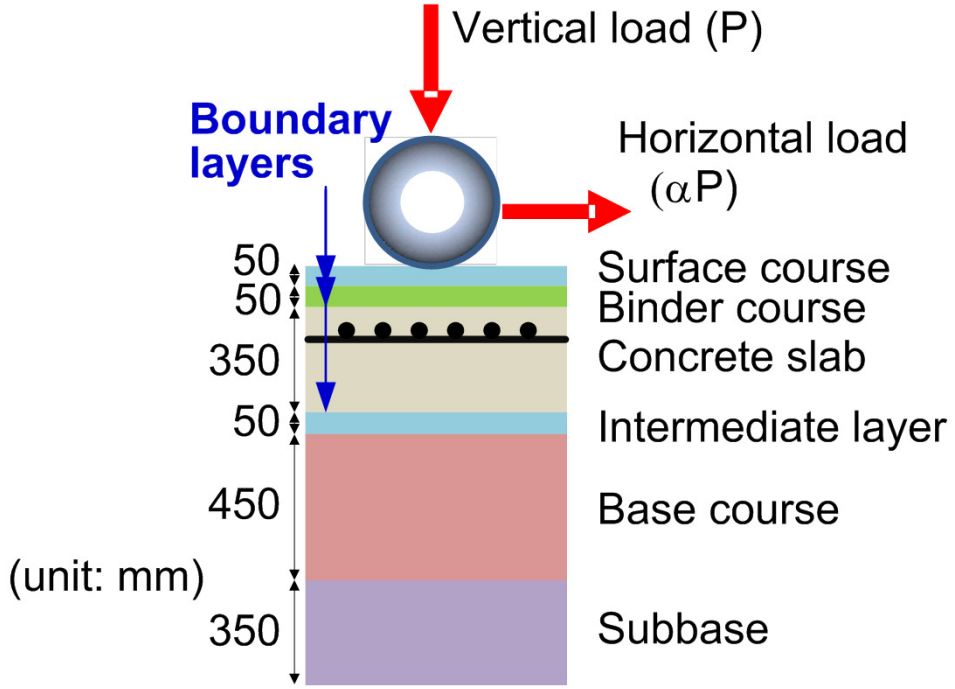
(unit: times/mm)

Chemical Compositions

- Black spots
  - Composed of the same substances as asphalt emulsion and asphalt
- White spots
  - Recognized as inorganic and containing calcium carbonates
  - No obvious differences at fractured planes and others
- Stains at construction joint
  - Made of the same substances as white spots

Structural Analysis with 3D-FEM

- Pavement modeling

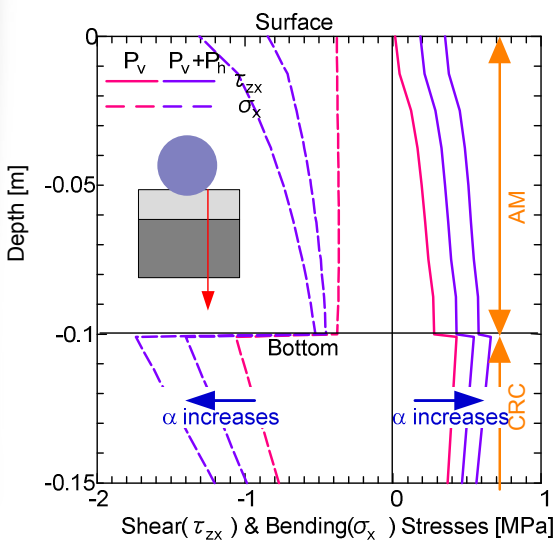


- Analytical conditions

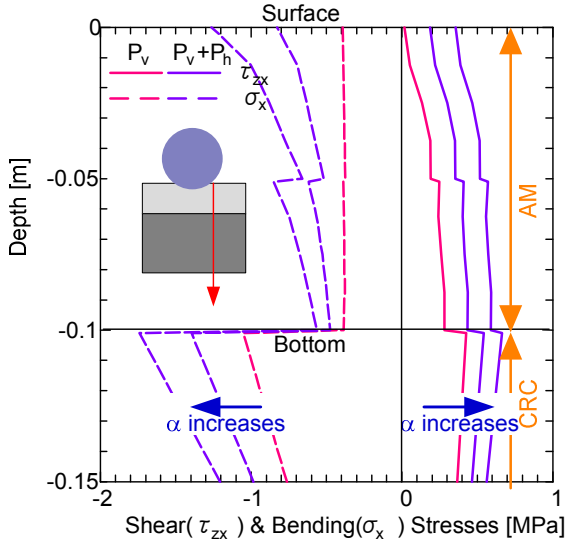
CASE	Temperature	Bonding at interface
1	Surface = Binder	Fully bonded
2	Surface > Binder	Fully bonded
3	Surface > Binder	Separated

Results of Analysis (1)

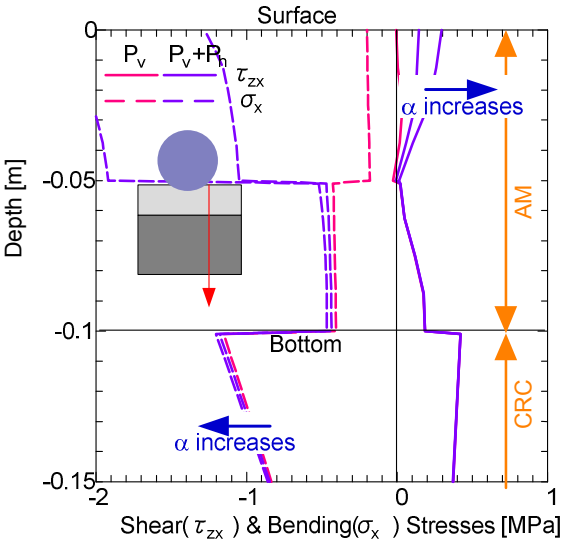
- In CASEs 1 and 2, stress between AM and CRC is larger than AMs.
- In CASE 3, stress between AMs is much larger than AM and CRC.



CASE 1



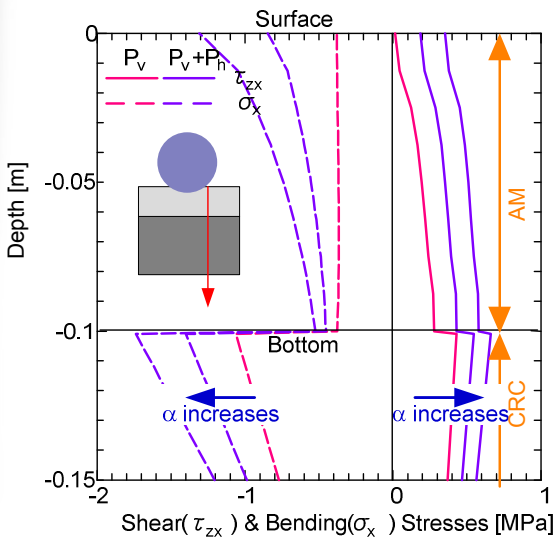
CASE 2



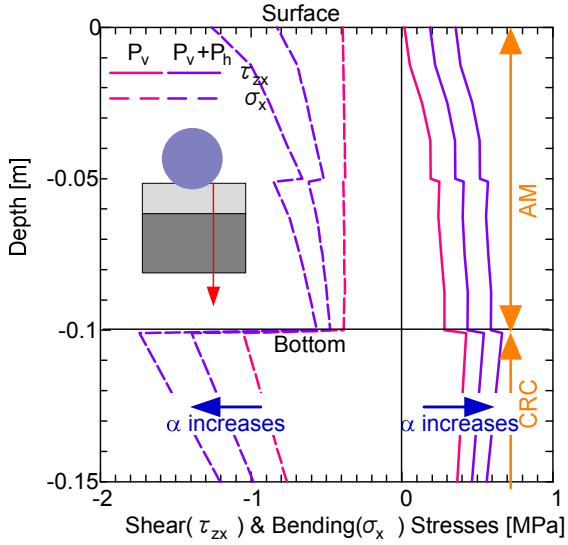
CASE 3

Results of Analysis (2)

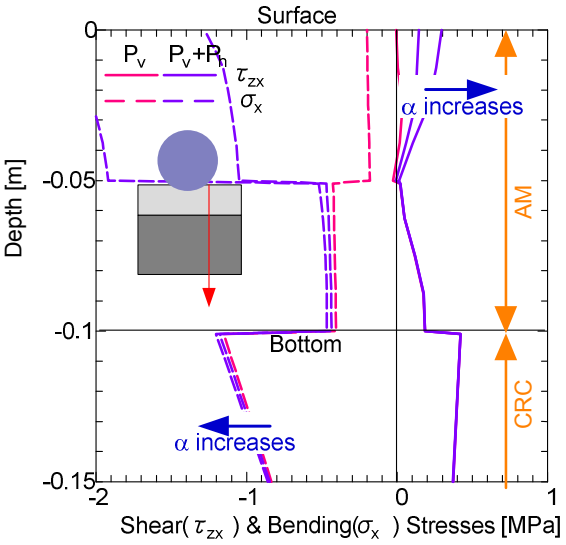
- Stress in CASE 3 is lager than CASEs 1 and 2.
- Little risk of separation between AMs as long as the bonding is secured.



CASE 1



CASE 2



CASE 3

Causes of Signs of Distress

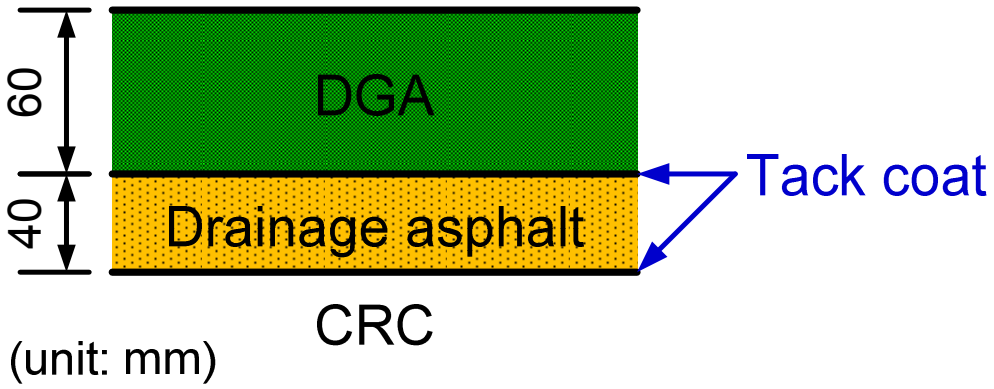
- Dull sound at hammer tapping tests
  - Insufficient stability of AM
    - DS was lower than the new standard
    - Air void was below the standard
  - Water remained in AM
    - Might cause blistering
- Black & white spots and stains at joints
  - Asphalt exfoliation & efflorescence from concrete were found
- Flow of AM around airport lighting
  - Insufficient stability of AM

Causes of Major Distress

- Intrusion of water into AM
  - AM layers with low air voids were surrounded by CRC on the bottom and all sides.
  - Once water has permeated the pavement, it cannot naturally escape from it.
- Low stability of AM
  - Stability of AM insufficient to carry heavy aircraft loads resulted in plastic deformation progressed by repeated load applications.

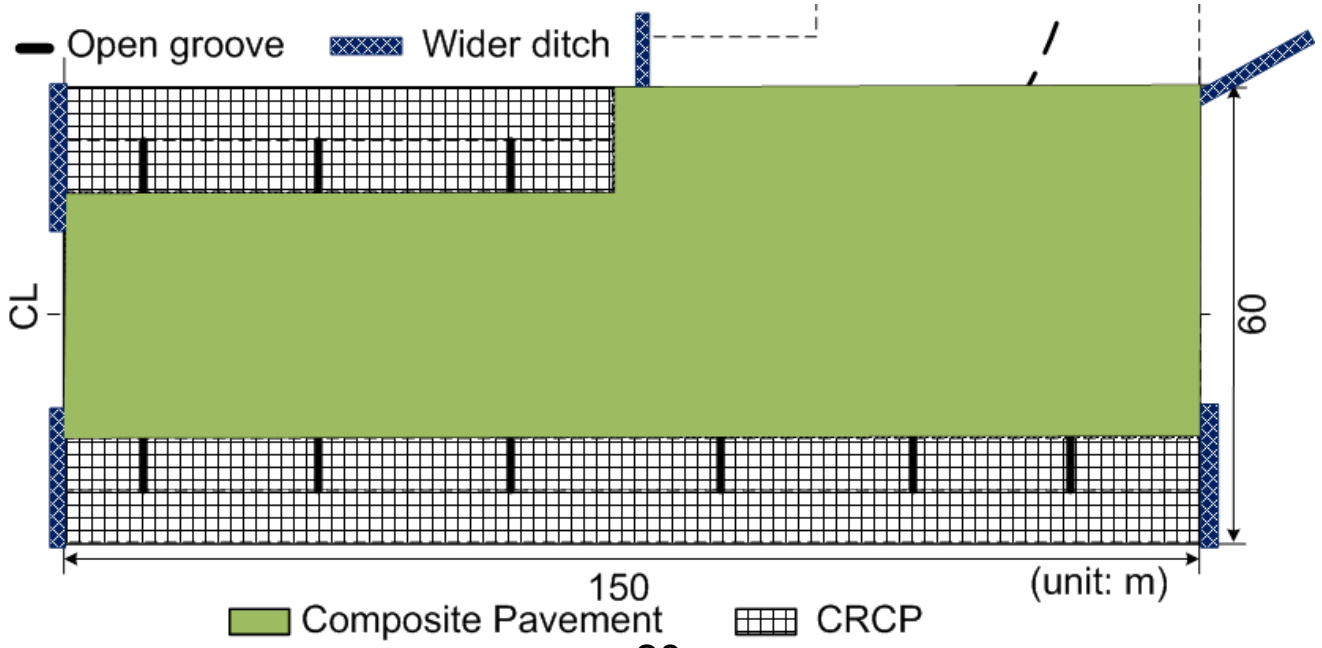
Rehabilitation Plan (1)

- **Countermeasures against Intrusion of water into AM (1)**
  - Pavement structure
    - PM DGA of 60 mm thickness and 4.5% air void
    - PM drainage asphalt of 40 mm thickness and 20% air void (about 0.01 cm/s permeability)
    - Emulsified PM asphalt tack coat



Rehabilitation Plan (2)

- **Countermeasures against Intrusion of water into AM (2)**
  - **Water draining facilities**
    - Transverse open grooves of 6 – 10 mm width
    - Wider ditches filled with drainage asphalt



Rehabilitation Plan (3)

- **Countermeasures against low stability of AM**
  - Asphalt mixture with DS > 3,000 times/mm is required.
    - PMA Type II is adopted for surface course
    - PMA Type H is adopted for binder course

Item	Straight (40 – 60)	PMA	
		II	H
Softening point (°C)	47 – 55	> 56.0	> 80.0
Ductility at 15°C (cm)	> 10	> 50	-
Toughness at 25°C (Nm)	-	> 8.0	> 20
Tenacity at 25°C (Nm)	-	> 4.0	-

Summary

- Causes of distress in composite pavements
  - Intrusion of water in composite pavements
  - Low stability of asphalt mixtures
- Rehabilitation methods
  - Pavement structure
  - Water draining facilities
  - Asphalt mixtures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